A NEW SUBGENUS FOR SIX INDO-AUSTRALIAN SPECIES OF *BACTROCERA* MACQUART (DIPTERA: TEPHRITIDAE: DACINAE) AND SUBGENERIC TRANSFER OF FOUR OTHER SPECIES

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Abstract

Calodacus subgen. n. is proposed to include six species of Asian and Australasian *Bactrocera* Macquart species formerly included in subgenus *Gymnodacus* Munro, viz: *B. (C.) calophylli* (Perkins & May) [type species], *B. (C.) continua* (Bezzi), *B. (C.) hastigerina* (Hardy), *B. (C.) kuniyoshii* (Shiraki), *B. (C.) symplocos* Drew & Romig and *B. (C.) tillyardi* (Perkins). An additional Papua New Guinea species, *B. petila* Drew, is transferred from subgenus *Gymnodacus* to subgenus *Bactrocera*, together with three SE Asian species, *B digressa* Radhakrishnan, *B. fastigata* Tsuruta & White and *B. rutengiae* Drew & Romig, currently included in the Afrotropical subgenus *Daculus* Speiser or its synonym *Afrodacus* Bezzi.

Introduction

The subgeneric classification of the large fruit fly genus *Bactrocera* Macquart has undergone much modification in recent years. Drew (1989) and Drew and Romig (2013) effectively placed most Australian-Oceanian and Southeast Asian species into a currently acceptable arrangement, although a few uncertainties remained. White and Evenhuis (1999) and White (2006) noted that Indo-Australian species currently included in subgenus *Gymnodacus* Munro differed significantly from typical African species, particularly in the deeper emargination to abdominal sternum V, the presence of yellow colouration on the anatergite and the short extension to wing cell bcu. Whereas the Afrotropical subgenera *Gymnodacus* and *Daculus* Speiser (including its synonym *Afrodacus* Bezzi) are referable to the *Melanodacus* group of subgenera (Drew and Hancock 1999), Indo-Australian species referred to these subgenera are typical of the *Bactrocera* group of subgenera, characterised by the combination of a short surstylus lobe and deep emargination to sternum V. Accordingly, a new subgenus is proposed below to accommodate six of the Australasian and SE Asian species currently included in *Gymnodacus* (Drew 1989, Drew and Romig 2013). The placement of an additional Papua New Guinea species in *Gymnodacus* and three SE Asian species in *Daculus* and *Afrodacus* is also reassessed.

Bactrocera (*Calodacus*) subgen. n.

Type species *Asiadacus calophylli* Perkins & May, by present designation.

Definition. Posterior lobe of male surstylus short; abdominal sternum V of male deeply concave on posterior margin; pecten of cilia absent from tergum III of male; postpronotal setae absent; supra-alar setae present except in *B. continua* (Hardy); prescutellar acrostichal setae present except in *B. hastigerina* (Hardy); one pair of scutellar setae; wing cell bcu with extension short; bulla in male wing absent; anatergite and katatergite both largely yellow; shining spots (ceromata) on abdominal tergum V present.

Etymology. The name is derived from that of the type-species: *calo-* plus the suffix *-dacus*. Alphabetically, it follows immediately after its presumed sister-subgenus, *Bulladacus* Drew & Hancock.

Response to male lures. None known for any of the included species.

Comments. Calodacus appears to be closely related to subgenus *Bulladacus*, as noted by White and Evenhuis (1999), with both having comparatively short antennae, a short extension to wing cell bcu and neither responding to known lures; it differs in the presence of the abdominal shining spots (ceromata) on tergum V. Typical *Bulladacus* also differs in the presence of the bulla on the male wing and presence of the pecten on abdominal tergum III, although at least two Papua New Guinea species (*B. aceraglans* White & Evenhuis, 1999 and *B.* sp. near *aceraglans* White & Evenhuis, 1999) lack both these characters (White and Evenhuis 1999). However, they also lack the ceromata and are therefore provisionally retained in the latter subgenus. Interestingly, *B. aceraglans* has a patch of long cilia where the male bulla usually occurs and a *Bulladacus*-like abdomen, adding further support to their current placement.

Included species. Six species are referred to subgenus *Calodacus*: *B. (C.) calophylli* (Perkins & May, 1949) from southern Thailand and the Andaman Islands to Australia, Solomon Islands and Vanuatu; *B. (C.) continua* (Bezzi, 1919) from the Philippines; *B. (C.) hastigerina* (Hardy, 1954) from Papua New Guinea (New Britain) and Solomon Islands (Guadalcanal); *B. (C.) kuniyoshii* (Shiraki, 1968) from Japan (Ryukyu Islands); *B. (C.) symplocos* Drew & Romig, 2013 from Thailand; and *B. (C.) tillyardi* (Perkins, 1938 (= *absona* Hering, 1941) from Burma and Peninsula Malaysia [all transferred from subgenus *Gymnodacus*]. For illustrations and further morphological details see Drew (1989) and Drew and Romig (2001, 2013).

Host plants. Recorded host plants include *Calophyllum inophyllum* (Clusiaceae) [*B. calophylli*], *Spondias cytherea* (Anacardiaceae) [*B. hastigerina*], *Symplocos cochinchinensis* (Symplocaceae), *Sapium baccatum* (Euphorbiaceae) and *Spondias pinnata* (Anacardiaceae) [*B. symplocos*] (Drew and Romig 2001, 2013).

Key to species of subgenus *Calodacus*

1 Scutum black without postsutural yellow vittae; postpronotal lobes yellow with narrow black anterior and inner margins; scutellum with a broad black basal band; wing with costal band broadly interrupted in cell r_1 and narrow dark bands present along R-M and DM-Cu crossveins (Burma and West Malaysia) ..... *B. (C.) tillyardi* (Perkins, 1938)

– Scutum black or pale but with a pair of distinct postsutural lateral yellow vittae; postpronotal lobes entirely yellow; scutellum with only a narrow dark basal band; wing with costal band not interrupted in cell r_1 and without dark bands along R-M and DM-Cu crossveins 2

2 Scutum orange-brown; postpronotal lobes connected to postsutural vittae by presutural lateral yellow vittae; postsutural lateral yellow vittae triangular, narrowing posteriorly; anepisternal yellow stripe reaching postpronotal lobe anteriorly; wing with costal cells bc and c densely microtrichose (Philippines) ..... *B. (C.) continua* (Bezzi, 1919)

– Scutum black or red-brown with broad dark markings; presutural lateral yellow vittae absent; postsutural lateral yellow vittae parallel-sided, not distinctly narrowing posteriorly; anepisternal yellow stripe not reaching postpronotal lobe anteriorly; wing with costal cells bc and c densely microtrichose only in outer half of cell c 3

3 Scutum with postsutural lateral yellow vittae narrow and not reaching intra-alar setae; legs fulvous except fore and hind tibiae pale fuscous 4

– Scutum black with postsutural lateral yellow vittae broad and enclosing intra-alar setae; legs with all tibiae and apices of all femora fuscous to dark fuscous 5

4 Scutum red-brown with broad dark markings; costal cells bc and c pale fuscous; prescutellar setae absent; abdomen with indistinct dark markings across base of tergum III and narrow fuscous medial vittae on terga III-V not forming a distinct, continuous stripe (Papua New Guinea: New Britain and Solomon Islands: Guadalcanal) ..... *B. (C.) hastigerina* (Hardy, 1954)

– Scutum black; costal cells bc and c with a pale fuscous tint; prescutellar setae present; abdomen with a distinct black band across base of tergum III and a distinct black medial vitta on terga III-V (India: Andaman and Nicobar Islands, southern Thailand: Songkhla, West Malaysia, Singapore, Australia: NE Queensland, Solomon Islands: Guadalcanal and Vanuatu: Espiritu Santo) ..... *B. (C.) calophylli* (Perkins & May, 1949)

5 Facial spots small and elongate-oval; all femora with broad fuscous apices; abdominal terga III-V with lateral margins at most indistinctly darkened and with a broad medial vitta (Japan: Ryukyu Islands) .... *B. (C.) kuniyoshii* (Shiraki, 1968)

– Facial spots large and circular; fore femora with an elongate subapical fuscous spot; mid and hind femora with narrow fuscous apices; abdominal terga III-V with broad black lateral margins and with a narrow medial vitta (Thailand) ..... *B. (C.) symplocos* Drew & Romig, 2013

Other Indo-Australian '*Gymnodacus*' species

The Papua New Guinea species *Bactrocera petila* Drew, 1989 was originally placed in subgenus *Gymnodacus* by Drew (1989) but differs from those included here in *Calodacus* in having comparatively longer antennae, an elongate-oval abdomen and an elongate cell bcu extension coupled with a broad anal stripe that meets vein CuA_1 near the apex of cell bm; it also

responds to cue-lure (Drew 1989). Fitting in neither typical *Gymnodacus* nor *Calodacus*, it is regarded here as an aberrant species of subgenus *Bactrocera*, characterised by the lack of the male abdominal pecten on tergum III.

Indo-Australian '*Daculus*' and '*Afrodacus*' species

Subgenus *Afrodacus* was placed as a junior synonym of *Daculus* by Copeland *et al.* (2004) and restricted to the Afrotropical Region (except for its type-species *B. (D.) oleae* (Rossi, 1790), which extends into Europe and SW Asia). The Indo-Australian species *B. brunnea* (Perkins & May, 1949), *B. fastigata* Tsuruta & White, 2001, *B. grandistylus* Drew & Hancock, 1995, *B. hypomelaina* Drew, 1989, *B. jarvisi* (Tryon, 1927), *B. minuta* (Drew, 1971) and *B. ochracea* Drew, 1989 were all transferred to subgenus *Bactrocera* by Copeland *et al.* (2004) and this placement was followed for the Australian species *B. brunnea* and *B. jarvisi* by Hancock (2013). The Indian-Sri Lankan species *B. fastigata* was retained in '*Afrodacus*' by Drew and Romig (2013), who also included, with considerable reservation, two additional species in subgenus *Daculus*, *viz. B. digressa* Radhakrishnan, 1999 (= *yercaudiae* Drew, 2002: David and Ramani 2011) and *B. rutengiae* Drew & Romig, 2013. These three species are regarded here as aberrant species of subgenus *Bactrocera*, characterised by the absence of supra-alar (and often also prescutellar acrostichal) setae.

The 10 subgeneric changes proposed here are listed in Table 1.

Table 1. Subgeneric placement of Indo-Australian *Bactrocera* species here removed from subgenera *Gymnodacus*, *Daculus* and *Afrodacus*.

As currently placed	Revised placement
Australian-Oceanian taxa [1]	
B. (Gymnodacus) calophylli (Perkins & May)	*B. (Calodacus) calophylli*
B. (Gymnodacus) hastigerina (Hardy)	*B. (Calodacus) hastigerina*
B. (Gymnodacus) petila Drew	*B. (Bactrocera) petila*
SE Asian taxa [2]	
B. (Afrodacus) fastigata Tsuruta & White	*B. (Bactrocera) fastigata* [3]
B. (Daculus) digressa Radhakrishnan	*B. (Bactrocera) digressa* [4]
B. (Daculus) rutengiae Drew & Romig	*B. (Bactrocera) rutengiae*
B. (Gymnodacus) calophylli (Perkins & May)	*B. (Calodacus) calophylli*
B. (Gymnodacus) continua (Bezzi)	*B. (Calodacus) continua*
B. (Gymnodacus) kuniyoshii (Shiraki)	*B. (Calodacus) kuniyoshii*
B. (Gymnodacus) symplocos Drew & Romig	*B. (Calodacus) symplocos*
B. (Gymnodacus) tillyardi (Perkins)	*B. (Calodacus) tillyardi*

[1] As treated by Drew (1989). [2] As treated by Drew and Romig (2013), with *B. (G.) absona* (Hering) included as a synonym of *B. tillyardi*. [3] As originally proposed by Copeland *et al.* (2004). [4] As placed originally and by David and Ramani (2011).

Bactrocera decurtans* and *B. murrayi

Two Australian species, *B. decurtans* (May, 1965) and *B. murrayi* (Perkins, 1939), would also fit the concept of '*Daculus*' as used by Drew and Romig (2013). Provisionally included in subgenus *Polistomimetes* Enderlein (now placed as a synonym of subgenus *Tetradacus* Miyake) by Drew (1989), these two species were placed in subgenus *Bactrocera* by Hancock *et al.* (2000) and Hancock (2013), as originally suggested by Drew (1989).

Relationships and biogeography of *Calodacus* species

The six species of *Calodacus* form two species pairs and two isolated taxa. The two most easterly occurring species, *B. calophylli* and *B. hastigerina*, share the characters of narrow postsutural lateral yellow vittae that do not reach the intra-alar setae and pale legs with only the fore- and hind tibiae darkened. Although *B. calophylli* is widespread from the Andaman Islands and southern peninsular Thailand to Australia, the Solomon Islands and Vanuatu, *B. hastigerina* appears to be restricted to the Bismarck and Solomon Islands. The extensive distribution of *B. calophylli* likely results from its use of the widespread coastal tree *Calophyllum inophyllum* as its host.

The two East and Southeast Asian species *B. kuniyoshii* and *B. symplocos* have broad postsutural lateral yellow vittae that enclose the intra-alar setae and legs with all tibiae and femoral apices darkened. These two species are allopatric, known from the Ryukyu Islands and Thailand respectively.

The Philippine species *B. continua*, with its distinctive pre- and postsutural lateral yellow vittae and broad anepisternal stripe, is known from the islands of Luzon and Batbatan. The broad postsutural vittae and dark apices to all femora suggest a relationship with the *kuniyoshii-symplocos* pair and its distribution largely supports this association.

The Southeast Asian *B. tillyardi,* with its distinctive wing and scutellar patterns and lack of postsutural lateral yellow vittae, is the most westerly recorded of the species, known from northern Burma and Peninsular Malaysia. In overall appearance it bears a striking resemblance to the Papua New Guinea species *B. (Trypetidacus) invisitata* Drew (which also lacks the pecten of cilia on abdominal tergum III in males), but that species lacks both supra-alar and prescutellar setae, has only a narrow basal black band on the scutellum, the anatergite black, costal band present in wing cell r_1 and a very short (rudimentary) cell bcu extension; it also responds to methyl eugenol (Drew 1989). *Bactrocera tillyardi* cannot be confidently associated with any other species, although its distribution also suggests a relationship with the *kuniyoshii-symplocos* pair.

On present evidence it is not possible to determine a centre of origin for the subgenus, which could be either Southeast Asia or the Australian Region. More information on distributions is needed and there is a high probability that other species await discovery: their lack of response to known lures

means that they are very poorly represented in collections. However, an apparent relationship with species in subgenus *Bulladacus* and possibly also with *B. (Queenslandacus) exigua* (May), the only other taxa with a deeply concave posterior margin to sternum V, short cell bcu extension, anatergite and katatergite largely yellow and no response to known lures, suggests that the Australian Region is a likely option.

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